CLAIMS

What is claimed is:

1. A process of making an electric current rectifying device using spatially coupled bipolar electrochemical deposition comprising:

(a) placing a source of electrically conductive material and at least two electrically conductive substrates and at least one semiconductor into an environment capable of conducting electricity and containing electrodes;

(b) aligning the substrates and the semiconductor with respect to the electrodes such that the electrodes are not in contact with the substrates or the semiconductor and such that the material will form a conductive structure between and in contact with the substrates and the semiconductor when an electric field is applied between the electrodes;

(c) applying a voltage to the electrodes to create a first electric field of a sufficient strength between the electrodes and for a time sufficient to form a first electrically conductive structure between and in contact with a first of the substrates and the semiconductor, the electrically conductive structure being substantially aligned with the first electric field;

(d) reversing the polarity of the voltage applied to create a second electric field of a sufficient strength between the electrodes and for a time sufficient to form a second electrically conductive structure between and in contact with a second of the substrates and the semiconductor, the electrically conductive structure being substantially aligned with the second electric field,

the semiconductor thus being transformed into the rectifying device.

2. A process of making an electric current rectifying device using spatially coupled bipolar electrochemical deposition comprising:

(a) placing at least two electrically conductive substrates comprising sources of electrically conductive material and at least one semiconductor into an environment capable of conducting electricity and containing electrodes;

(b) aligning the substrates and the semiconductor with respect to the electrodes such that the electrodes are not in contact with the

substrates or the semiconductor and such that the material will form a conductive structure between and in contact with the substrates and the semiconductor when an electric field is applied between the electrodes;

(c) applying a voltage to the electrodes to create a first electric field of a sufficient strength between the electrodes and for a time sufficient to form a first electrically conductive structure between and in contact with a first of the substrates and the semiconductor, the electrically conductive structure being substantially aligned with the first electric field;

(d) reversing the polarity of the voltage applied to create a second electric field of a sufficient strength between the electrodes and for a time sufficient to form a second electrically conductive structure between and in contact with a second of the substrates and the semiconductor, the electrically conductive structure being substantially aligned with the second electric field,

the semiconductor thus being transformed into the rectifying device.

3. The process of claim 1 or 2, wherein the source of the electrically conductive material is selected from the group consisting of a metal ion, a monomer which is electropolymerizable into a conductive polymer and an organic salt which is electrocrystallizable into a conductive crystal.

4. The process of claim 3, wherein the source of electrically conductive material is an ion selected from the group consisting of Cu, Ag, Au, Pd, Pt, Co, Ni, Zn, In, Ga, Fe, Pb, Al, W, Ir, Cr, Cd, Re, Os, Mn and Sn.

5. The process of claim 4, wherein the source of electrically conductive material is an ion selected from the group consisting of Cu and Ag.

6. The process of claim 1 or 2, wherein each substrate is independently selected from the group consisting of a metal, a metal oxide, a conductive polymer, a conductive organic salt crystal and a conductive form of carbon.

7. The process of claim 6, wherein each substrate is independently selected from the group consisting of Cu, Ag, Au and Pt.

8. The process according to claim 1 or 2, wherein the semiconductor is an n-type or a p-type and is selected from the group consisting of Si, InP, GaAs, CdS and CdSe.

9. The process of claim 1 or 2, wherein the environment is selected from the group consisting of a liquid and a gel, the environment having a dielectric constant lower than the dielectric constant for the substrate, the environment further being able to solvate the electroconductive material in a form in which the electroconductive material can electrodeposit onto the semiconductor upon application of an electric field.

10. The process of claim 9, wherein the environment is aqueous.

11. The process of claim 10, wherein the aqueous environment comprises water, an acid to remove oxides and a surfactant to prevent adhesion of gas bubbles.

12. The process of claim 9, wherein the environment comprises an organic solution.

13. The process of claim 12, wherein the organic solution is selected from the group consisting of acetonitrile and a mixture of toluene and acetonitrile in which the toluene is present in an amount of up to about 80 volume percent.

14. The process of claims 1 or 2, wherein each electrode comprises a material that will not electrodissolve in the environment.

15. The process of claim 14, wherein each electrode is independently selected from the group consisting of platinum, gold and graphite.

16. The process of claim 1 or 2, further comprising electrolessly plating an electrically conductive material onto the electrically conductive structures until a desired thickness of the electrically conductive material is obtained.

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17. The process of claim 16, wherein the electrolessly plated electrically conductive structures are in contact with the substrates and the semiconductor.

18. The process of claim 1 or 2, further comprising removing from the environment the substrates, the semiconductor and the conductive structures between the substrates and the semiconductor, and electrolessly plating an electrically conductive material onto the electrically conductive structure until a desired thickness of the electrically conductive material is obtained.

19. The process of claim 1 or 2, wherein the environment is a liquid environment, the process further comprising removing from the environment the substrates, the semiconductor and the conductive structures between the substrates and the semiconductor, drying the electrically conductive structures between the substrates and the semiconductor, and electrolessly plating an electrically conductive material onto the electrically conductive structures until a desired thickness of the electrically conductive material is obtained.

20. The process of claim 19 wherein the electrolessly plated electrically conductive structures are in contact with the substrates and the semiconductor.

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